these causes that is perceivable in comparing the observations with a barometer, as the scale is taken every ten degrees at one inch rise or fall of the barometer, the error then divided, which is extremely minute, and allowed for in the scale. Sympiesometers thus made will range with the barometer to the $\frac{1}{100}$th part of an inch, which convinces me that "Audax" would not have been deceived or perplexed if he had used my instrument.

With respect to those makers, whom he states, point their instruments at the heat of the common place of manufacture, I should not be inclined to think they do, as by those means it is plain they must guess at the scales. He should not write so bold, and say that all sympiesometer makers do manufacture them in such rude manner, until he had tested the instruments of different makers, for I am perfectly sure he has not used my Patent Mineral Sympiesometer, which he acknowledges, and likewise congratulated me on the success I had attained in bringing my instrument to such perfection.

In the last part of the letter there is doubt placed as to the instrument ever attaining mathematical perfection, which, I think, he is not justified in stating; for the instruments he draws his conclusion from are not by any means first rate, and the methods employed to discover the errors I place no faith in. If eventually they should be used for measuring the height of mountains, I have little doubt, but that I shall succeed in making them mathematically correct with the aid of tables. This extreme accuracy every one knows is not required at sea. The sympiesometer is much more correct than the marine barometer, is sooner affected, it does not require as "Audax" thinks gimballs if the barometric scale is a reasonable length, *i.e.* 1½ inch to 1 inch of the barometer, or thereabouts, not more, which is an error I think he has fallen into in the instruments he has caused to be made for his own use.

I am &c., CHARLES CUMMISS.

TIDE OBSERVATIONS.—*North Sea.—Professor Whewell's Theory.*

H.M.S. Shearwater, Harwich, July 18, 1842.

SIR.—I have the pleasure to acquaint you that, at length, we have been so far favoured by the weather as to allow us to carry out that part of your instructions which directs me "to lose no opportunity of repeating observations on the rise and fall of tide in the middle of the North Sea;" and the results would seem to prove the truth of Professor Whewell's theory that, "there exists a space of some extent about halfway between the coasts of Suffolk and Holland, in which there is no sensible rise or fall of the water."

On Tuesday the 12th inst., we were in lat. 52° 15½′ N., long. 3° 15′ E. of Greenwich, or about fifty-six miles from Lowestoft, and forty from the Brielle, and although this spot is on the extreme eastern edge of the space in which the cotidal lines meet, as represented in Mr. Whewell's Chart of Cotidal Lines, which illustrates his sixth series of "Researches on the tides," inserted in the Philosophical Transactions for 1836; and the time the second day after the highest springs, still I would not lose the favourable opportunity afforded by smooth water and a light breeze from the westward, and we proceeded accordingly to

take steps for measuring the tides with every precaution in our power for securing accuracy. The detailed results are recorded in the accompanying table; but I may state as a summary, that on carefully measuring through two whole ebbs and one flood, the water was only found to fall *sixteen inches* on two trials, and *eighteen inches* on the third; and had we been able to make the experiment fifteen miles farther west, which is the centre of the blank space in the before-mentioned Cotidal chart, I have little doubt but that we should have found no rise and fall at all.

On examining the results two or three points present themselves as worthy of notice, and *first*, That the level of the water remained quite stationary during the strength of the stream of tide, but the moment *that* slacked the water suddenly rose or suddenly fell; so much so that the whole rise and fall in each of the three instances to which our observations refer, took place in one hour and a half.

Secondly.—Both the rise and fall of the water occurred while the stream of tide, although quite slack, still drained to the north-east; that is while the *flood* stream, as it is called on the Dutch coast, was yet felt.

Thirdly.—In the P.M. observations the water began to rise, reached its level, and again fell to its lowest point in five hours and a half.

Fourthly.—That the water remained stationary at its lowest point for nearly seven hours.

Fifthly.—That assuming the times of high water to be at the mean interval of the water remaining stationary, the stream continued to run to the north-east for three hours after the time of high water, and to the south-west two hours after low water.

Sixthly.—That the stream of tide turned round *against the sun*, and from careful observations at a series of ten stations at eight miles apart entirely across the sea in the parallel of 52° 15′, we are now enabled to state that it always does so half way across from the coast of Holland, and the contrary, or, *with the sun* half way across from the coast of England, the meridian of 3° east is probably the exact dividing line.

Another remarkable confirmation of the correctness of Mr. Whewell's views with respect to the cotidal lines is also shewn by our results. On reference to the before named chart, it will be seen that the 2 o'clock cotidal line passes Katwyk on the coast of Holland, curves to the westward, and vanishes just at our station, now if we apply the corrected establishment at Katwyk 2h. 5m. to the moon's preceding, or lower transit, 3h. 30m. on this day, we have 5h. 35m. A.M. for the time of high water, and 6h. for the afternoon's tide, which corresponds exactly with our observations.

With respect to the fact of no rise and fall taking place during the strength of the stream, I may observe that the same peculiarity is found on the Leman and Ower Shoals (where the inward fall is twelve feet at springs) as first noticed by myself in 1826, when in the Protector, with that experienced surveyor, the late lamented Captain Hewett; and it would be a curious enquiry whether the same circumstances occur on other outlying banks in the North Sea, for if so, mariners should be on their guard, as in the event of being obliged to cross them they may be very much deceived as to the depth of water to be found on

them at what might be considered half-flood. Smiths Knowl, the Dudgeon, Races Bank, Outer Dowsing, and even Hasborough Sand may be thus circumstanced.

The greatest rate of tide stream observed by us is less than two knots at the springs.

Capt. Hewett has so fully detailed in his letter to you the method pursued in the Fairy in 1840, only fifteen miles further north, in measuring the rise and fall, that it seems unnecessary to say anything farther about it, except to point out in what we differed from him. Instead of seeking out a knoll or overfall, we sought the *flattest ground*, and instead of mooring our boat head and stern with the tide, we selected the lightest boat we had, (our tender's fourteen feet dingay,) and moored her with three whale line cables from the stem or bow, bousing them down at slackwater as tort as they would bear, leaving the boat's stern free to swing with the tide, thus there was little or no strain on the boat, and I do not think that her stem, which was the spot at which we sounded, moved six inches from its place during the day; the soundings were taken from another light boat which was allowed to drop with the tide, the lead being kept plumbing, and just lifted off the ground till the lead line touched the dingay's stem. I need hardly say that, the lead line was old and well worn, and we measured several times during the observations. The cables were of whale line thoroughly stretched, and the anchors were treble the weight of the usual boat's anchors, and every other precaution taken which common seamanship would suggest to ensure accuracy.

The depth at high water was 111 feet, or 18½ fathoms, and to shew how slight was the irregularity of the surface of the bottom, I may state that, on sounding around it was found that at seventy yards south-west of the boat the depth was only *three inches more;* at the same distance south-east it was nine inches less; at the same distance to the north-west twenty-three inches less, and to the north-east twenty-three inches less also, shewing a gradual slope of the ground from north to south of an *inch* in *three yards,* or less than one in a hundred.

It remains to add that the securing the boat, and measuring the depths during the whole day was done by Mr. E. K. Calver, master and assistant-surveyor of this ship, assisted by Mr. W. Woods of Aldborough, Trinity-pilot, and Moses Hunt and W. Marshall, Quartermasters; while, that we might not lose the opportunity of such calm weather for our survey, Lieutenant Cudlip, Senior Assistant-Surveyor, sounded in the ship over upwards of fifty miles of track in the course of the day.

In conclusion, I beg to offer my congratulations to Professor Whewell on the verification of his theory; and in common with all sailors, and with all interested in maritime affairs, to express to him and to Sir John Lubbock our best thanks for the able manner in which they have investigated the subject of tides, and the labour they have bestowed upon them during the last ten years, as evidenced in their valuable "Researches, &c." published in the Philosophical Transactions. It remains but for us sailors to supply them with correct data, and they will have little difficulty in reducing the Theory of Tides to almost the same accuracy already attained in other astronomical problems.

I am, Sir, &c. JOHN WASHINGTON, *Captain.*

12th July, 1842.
☽'s preceding transit 3 30 AM. } H.M.S. SHEARWATER. position { Lat. 52° 15½′ N. Lon. 3 15 E.

Mean Time at Place.	Height of Water.	Rise and Fall.	Stream of Tide. Direction.	Rate	Wind. Direction.	Force.	Weather	Remarks, &c.
A.M.	fm ft in	inch						AM.
5 0	18 3 0	—		1·2	S.S.W.	1		☾ preceding tran. 3 30
30	3 0	—		"	S.W.	1		Corrected establishment at Katwyk 2 5
6 0	3 0	—		1·0	"	1		
30	3 0	—	N.E.b.N.	"	"	"		
7 0	3 0	—	"	0·6	"	2		
30	2 9	3	"	"	"	"	ov	H.W. . . . 5 35
8 0	2 3	6	N.N.E.	0·2	W.S.W.	"	"	
30	1 8	7	N.	"	"	"	"	
9 0	1 8	—	W.S.W.	0·1	W.	"	"	
30	1 8	—	S.W.	"		"	"	
10 0	1 8	—	"	0·4		"	"	
30	1 8	—	"	"		"	"	
11 0	1 8	—	"	0·6	N.W.b.N.	2	"	
30	1 8	—	"	"	"	"	"	
12 0	1 8	—	"	1·2	"	"	"	L.W.
PM.								
0 30	1 8	—	S.W.		W.b.N.	1	bcv	
1 0	1 8	—	"	0·6	"	2		
30	1 8	—	"	"	"	1		
2 0	1 8	—	S.S.W.	0·2	"	2		
30	1 8	—	S.E.	"	"	1	"	
3 0	1 8	—	E.b.S.	0·6	"	"		
30	1 11	3	E.N.E.	"	W.S.W	1		
4 0	2 4	5	N.Eb.E.	1·4		"		
30	2 10	6	"	"		"		
5 0	3 0	2	"	1·5	S.W.	1		
30	3 0	—	N.E.	"	S.W.b.W.	1		
6 0	3 0	—	"	1·1	"	"		
30	3 0	—	"	"	"	"		
7 0	3 0	—	"	0·6	S.W.	1	"	
30	2 8	4	N.E.b.E	"				
8 0	2 1	7	"	0·4				
30	1 6	7	N.N.E.	"				
9 0	18 1 6	—	N.	0·2				
30								
10 0	too dark	for	further	obse	rvations.			
30								
11 0								
30								
12 0								

The slight inequality of the surface of the bottom may be judged of by the following depths:—
70 yds S.W. of boat 0 feet 3 inches, above
" S.E. " 0 9 under
" N.E. " 1 11 under
" N.W. " 1 11 under

JOHN WASHINGTON,
Captain.

RESULTS.

High water at 5h. 35m. AM.		Rise	
Low water at	noon	Fall AM. . .	16 inches
Flood stream ended at	2 0 PM.	Rise PM. . .	16 "
Ebb	8 0 8 30	Fall PM. . .	18 "

Chief Observer—Mr. E. K. Calver, Master and Assistant-Surveyor; assisted by Mr. W. Woods, Trinity-Pilot; Moses Hunt and W. Marshall, Quarter-Masters.